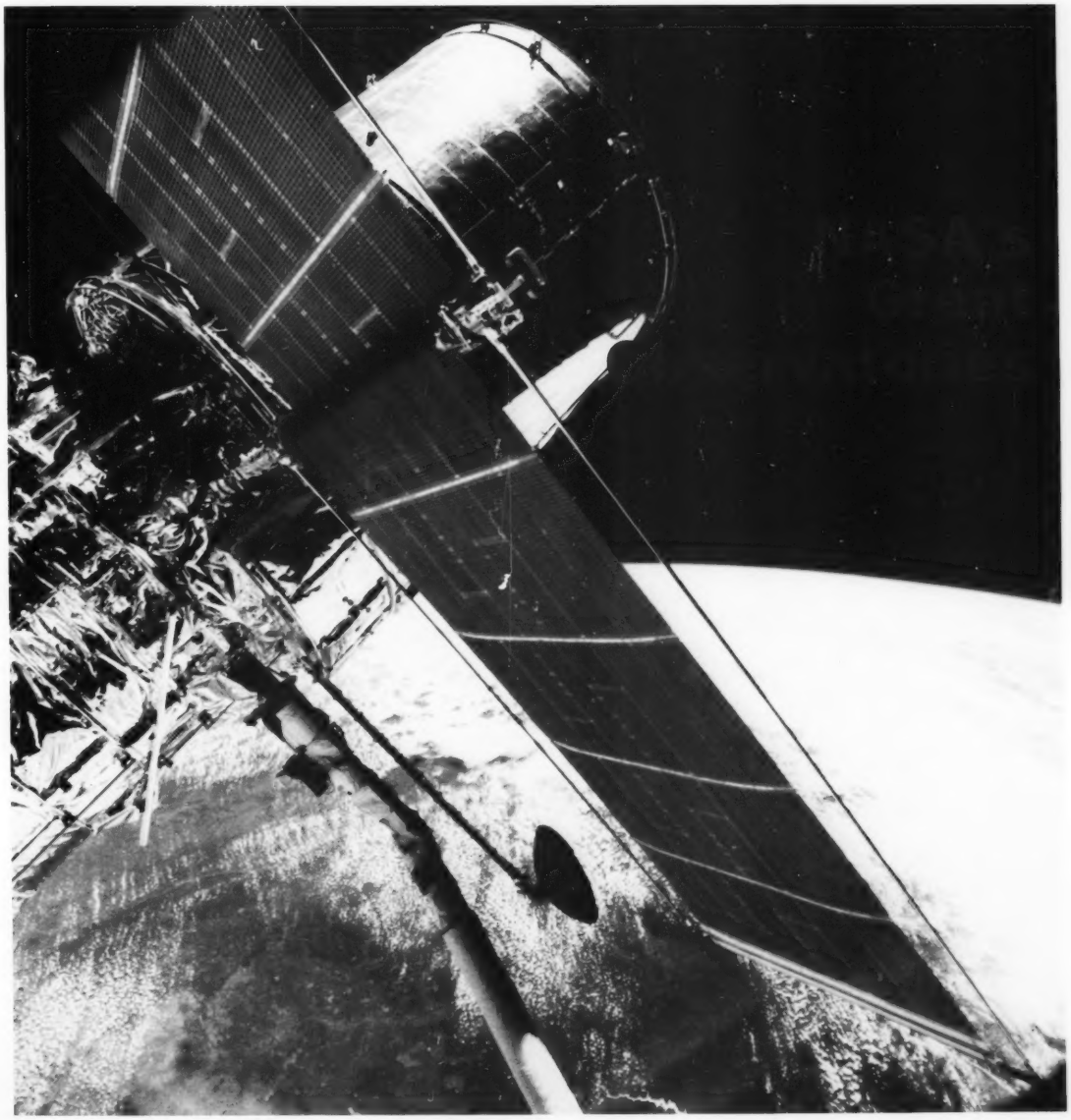
NASA Activities

National
Aeronautics and
Space
Administration

July/August 1990
Volume 21, No. 4



THIS ISSUE

While the upcoming millennium may or may not be a contributory factor in human progress, few can deny that we live in exciting times. The President's recent address at Texas A & I underscores the point that America is still on the move, that the spirit of the "American Adventure" is a force that will take humankind to Mars and instill greatness in a variety of our endeavors. Excerpts of the upbeat message are provided in this issue.

COBE, the Cosmic Background Explorer, pays its dues with an astounding portrait of the Milky Way galaxy, while NASA and ESA get ready to study the sun with Ulysses. See "Agency Highlights". NASA Visions provides the first light view from the Hubble Space Telescope and previews other NASA Great Observatories.

Flight through the air still reveals surprises as the X-29 shows better maneuverability than expected in high angle of attack attitudes and NASA begins flight research with the F-16XL to investigate supersonic laminar air flow. Langley engineers take to the water using flow technology to help the marine environment. The novel approach is covered in "Center Highlights". Finally, *Activities* looks back at Apollo-Soyuz and the contributions of Nancy G. Roman, NASA Astronomer.

Next Issue:
Ulysses and the Gamma Ray Observatory

CONTENTS

Official Comment
On Mars by 2019 a.d.—An American Adventure 3

Agency Highlights
The External Fellowship Program—'89-'90 Participants 5
Truly Presented Space Model by Canadian School 6
Take Pride in America Program 6
Milky Way Galaxy Portrayed 7
Nine Firms Named Excellence Award Finalists 7
Carnegie Mellon University Develops Planetary Robot 8
KSC Prepares Ulysses for Mission to the Sun 9
NASP Contractor Team Announced 9
NASA News Capsules 10
NASA Visions—Hubble First Light Images Sharp 11
NASA's Great Observatories 12

Center Highlights
F-16XL Aircraft Laminar Flow Studies Set to Begin 15
X-29 Shows Unexpected Maneuverability 15
Lines Drawn for JSC's New Organization 16
Ames Unveils Human Performance Research Lab 17
Effects of Tropical-Forest Burning 17
Langley, Marine Scientists Test Bay Clean-up Technology 18
"Antique" Crawler Transporter 19

Departments
NASA Story: "Apollo-Soyuz Test Project" 20
Biography: "Nancy G. Roman—NASA Astronomer" 21
Human Factors 22
Another Dividend From Air & Space 24

About the Cover

Suspended in space by the Shuttle Discovery's remote manipulator system, the giant Hubble Space Telescope awaits release. First of the major "Great Observatories" to be launched into space by NASA, it symbolizes the beginning of a "Golden Age" in the exploration of the universe.

NASA Activities is published bi-monthly by the National Aeronautics and Space Administration for the information of the Agency's employees. Contributions and recommendations are solicited from Headquarters and field centers, and should be addressed to Editor, NASA Activities, Internal Communications Branch, Code POC, NASA Headquarters, Washington, DC 20546.

NASA Activities is distributed free of charge only to agency employees. This publication is available by subscription from the Superintendent of Documents, Washington, DC 20402. Checks or money orders should be made payable to Superintendent of Documents, GPO. Subscription rates are $8.00/year, domestic; $10.00/year, foreign.

Les Reinertson
Editor

Mustafa Muhammad
Asst. to the Editor

NASA Headquarters
Washington, DC 20546
Phone: (202) 453-8425

OFFICIAL COMMENT

On Mars by 2019 a.d.— An American Adventure

(Excerpts of remarks by the President at Texas A & I University, May 11, 1990)

The American adventure has always had the capacity to inspire others and to astonish the world — the voyages of Columbus; the Declaration of Independence; the taming of a continent; the invention of flight.

America's democracy is the world's greatest experiment in freedom and diversity, an ongoing experiment that continues to unleash the creative energies of the world's most diverse population. It is what took American pioneers to the Moon and back. It is what will take you as far as your dreams can soar.

Of course, Texas has always had its share of pioneers and visionaries. One was Sam Houston. Where others saw empty plains and dust, he saw farms, and ranches, and towns. Where others saw obstacles, he saw opportunity.

But Houston could scarcely have imagined that, little more than a hundred years after his death, the entire planet would hold its breath as his name became the first word ever uttered on the plains and dust of another world.

It was July 20, 1969. And although Apollo 11 had just survived one of the most harrowing landings in the history of space, the voice of Neil Armstrong was confident, strong, American. He said: "Houston: Tranquility Base here. The Eagle has landed." Eight words. And the world was changed forever.

When America accepted the Apollo challenge, we rolled up our sleeves and took on a daunting and dangerous job. Apollo 11 showed we could meet our commitments to ourselves and to the world — proof that democracy could triumph as decisively in peace as it had in war. It lifted the spirits of a generation, and raised forever the horizons of the human race.

President George Bush

Last summer, in a speech commemorating the 20th anniversary of the Apollo Moon landing, I announced three major space policy objectives: First, to have Space Station Freedom up before the century is out. Second, for the new century, a permanent lunar base: "Back to the Moon, back to the future — and this time — back to stay." And third, a manned expedition to Mars.

Together, these objectives form the cornerstone of my Administration's far-reaching plan for investing in America's future. Our space program will help rekindle public interest in science and mathematics, and revitalize an area of our educational system that has become disturbingly weak. In fact, one of the education goals we announced in January is to make the United States first in math and science by the year 2000. But our space program will do more. It will revolutionize everything from computers to communications, from medicine to metals, regaining and retaining America's high-tech competitive edge. It will create new technologies, new industries, and new jobs.

It's an adventure I hope many of you will be part of. And it's an adventure that's already underway.

You are coming of age during a Golden Age of space. And there's no better example of this than the miracle now orbiting 380 miles above Kingsville — the Hubble Space Telescope. It will see to the furthest reaches of the universe, to the very edges of time. And it's hoped that the telescope will see objects so clearly that, in theory, it could pick out the writing on a dime — 100 miles away.

And even while Galileo and Hubble begin looking out across space — another array of new satellites will be looking back at Earth — and taking the pulse of the most important planet in the universe.

We call this initiative "Mission to Planet Earth." It's an effort of such magnitude, it dwarfs everything in the past — a worldwide study of the complex interactions between land, sea, ice and air — as well as between the Earth and the

A Martian sunset over Chryse Planitia, Mars, August 20, 1976.

Sun. It's an effort of global interest, in which we're inviting other nations to join. As Chairman of the National Space Council, the Vice President has just returned from Europe, where our allies expressed serious interest in both "Mission to Planet Earth" and in our continuing exploration of the Solar System.

Initiatives like these mark a critical investment in America's future. They will help protect the environment, fuel an educational renaissance, and hone America's competitive edge.

But the importance of the space program — especially the manned space program — goes deeper than that. Throughout our history, America has been a nation of discoverers. It is part of our national character — part of our democratic heritage. In fact, Monday marks the day in 1804 when Meriwether Lewis and William Clark set out across the Mississippi to map much of what was to become the great American West. Despite Thomas Jefferson's love of machines — it's hard to imagine his sending a robot out alone to describe the wonders of the American Rockies and the Pacific coast. In the American experiment — in the experiment called democracy — there will always be a place for individual men and women with imagination and daring.

Our Nation's quest for the unknown took American pioneers from the bluffs of the Mississippi to the mountains of the Moon. But today, we're no longer just asking for the Moon. We've been there. We're looking further, to carry the American adventure to wherever opportunity, curiosity, and need will take us.

It's time to open up the final frontier. There can be no turning back. America's space program is what civilization needs to begin this journey, and to perfect the commitment to go beyond. Each time we go to the frontier and beyond, we bring back more than we hoped for. This time we have the chance to bring back more than we can imagine.

Our 1991 budget is proof positive of America's commitment to an active, exciting and continuing presence in space — to America's leadership in space. Our budget proposes $15.2 billion for NASA, an increase of 24 percent — almost $3 billion — which is the largest increase for any major agency of the government.

But leadership in space takes more than just dollars. It also takes a decision. And I'm announcing one today.

We stand at a halfway point in our exploration of the immediate solar system — the planet Earth, its moon, and the terrestrial neighborhood. Thirty years ago, NASA was founded and the space race began. And 30 years from now I believe Man will stand on another planet. And so I am pleased to return to Texas today to announce a new Age of Exploration, with not only a goal but also a timetable: I believe that before Apollo celebrates the 50th anniversary of its landing on the moon — the American flag should be planted on Mars. ■

Our Nation's quest for the unknown took American pioneers from the bluffs of the Mississippi to the mountains of the Moon. ...Today, we're no longer just asking for the Moon. ...We're looking further, to carry the American adventure to wherever opportunity, curiosity, and need will take us.

The External Fellowship Program for Future Leaders

By Marcia Nickols, Hq

The Human Resources and Organization Development office identifies and arranges appropriate developmental experiences for NASA's future leaders. Its fellowship programs range from one-week university seminars to a calendar year in length, and include both degree and non-degree programs. There have been 390 participants in both university and non-university based fellowships.

External fellowship participants are selected through a rigorous screening process which includes interviews by a panel of top management representatives from across NASA. This Executive Development Education Panel is a subcommittee of the NASA Human Resources Council, and makes recommendations for selection to that Council's chairman, the associate deputy administrator. Competition generally is keen, since past recipients often have emerged in leadership roles within the agency. For example, Dale Compton and Jack Lee have become center directors, at Ames Research Center and Marshall Space Flight Center, respectively, since attending the Harvard Advanced Management Program.

The MIT-Sloan Fellows Program has produced two more graduates who have progressed this past year to very senior positions at NASA: Victor Peterson from the Ames Research Center has become the deputy director for that center, and Alphonso Diaz is now the deputy associate administrator for Space Science and Applications. Gerald Smith, a recent graduate of the Carnegie-Mellon Senior Executive Program from MSFC, has moved to Stennis Space Center as deputy director. NASA sponsors participants for training funds, as well as travel and subsistence support, with an eye to the best possible return on investment.

The list of 1989-1990 participants and fellowship programs below gives an idea of the breadth of subject matter under fellowships.

1989-1990 Fellowship Participants

CARNEGIE-MELLON SENIOR EXECUTIVE SEMINAR
Walter C. Hoggard, LaRC
Gerald W. Smith, MSFC
Sidney P. Saucier, MSFC
Norman H. Chaffee, JSC

DRYDEN MEMORIAL FELLOWSHIP
Dr. John E. Lamar, LaRC

HARVARD ADVANCED MANAGEMENT PROGRAM
Thomas Utsman, KSC
James Ehl, Hq

HARVARD MID-CAREER MASTER IN PUBLIC ADMINISTRATION
Connie Cunningham, ARC

HARVARD PROGRAM FOR MANAGEMENT DEVELOPMENT
Thomas G. Campbell, LaRC

HARVARD PROGRAM FOR SENIOR EXECUTIVE FELLOWS
Angela M. Phillips, Hq
Ray V. Hood, Hq

HARVARD PROGRAM FOR SENIOR MANAGERS IN GOVERNMENT
Robert T. Wingate, LaRC
Lynn W. Heninger, Hq

INDUSTRIAL COLLEGE OF THE ARMED FORCES (ICAF)
John P. Sheahan, Hq

MIT CENTER FOR ADVANCED STUDIES IN ENGINEERING
William E. Howell, LaRC

PENN STATE ENGINEER/ SCIENTIST AS MANAGER PROGRAM
William Langdoc, JSC

PENN STATE MANAGEMENT PROGRAM FOR WOMEN
Tandi M. Bagian, JSC
Deborah L. Sharpe, GSFC
Laura J. Milam, GSFC
Mary Ann Bolton, KSC
Suzanne F. DeSaix, Hq

SIMMONS COLLEGE - PROGRAM FOR DEVELOPING EXECUTIVES
Marta R. Bohn-Meyer, ARC
Buena E. Crawford, LaRC

SIMMONS COLLEGE - PROGRAM FOR DEVELOPING MANAGERS
Estella H. Gillette, JSC
Teresa L. Kurtz, ARC
Anne N. Bullock, Hq
Carol G. Jorgensen, GSFC

SMITH MANAGEMENT PROGRAM FOR WOMEN
Kathy H. Abbott, LaRC
Debra L. Johnson, JSC

STANFORD SLOAN FELLOWS PROGRAM
Dr. Philip B. Russell, ARC

SYRACUSE-MAXWELL MID-CAREER PROGRAM
Mr. Charles E. Cockrell, LaRC

FEDERAL EXECUTIVE INSTITUTE
John F. Garren, LaRC
Dr. Michael Greenfield, Hq
Wesley Dean, KSC
H. Milton Holt, LaRC
Jay H. Greene, JSC
Judy Simonds, Hq
Salvador Rositano, ARC
Charles Chappell, MSFC
Frank Owens, Hq
James E. Jennings, KSC
Sammie D. Joplin, LaRC
Dr. Alan N. Bunner, Hq
Dr. H. Lee Beach, LaRC
William Piland, LaRC
Brent Miller, LeRC

AGENCY HIGHLIGHTS

Truly Presented Space Model by Canadian School

Canadian seventh-grader J. D. Wisner (right) presents NASA Administrator Richard H. Truly with a scale model of Skylab from the C.C. McClean Public School, Manitoulin Island, Ontario.

NASA Administrator Richard H. Truly met in Ottawa with representatives from the Highly Gifted and Talented Student program of the Manitoulin Island Board of Education, Ontario, Canada. Seventh grade student J.D. Wisner from C.C. McClean Public School and Dianna Shaffer, program teacher, represented the students and faculty.

As a part of their curriculum, Shaffer's students have spent the last year studying the development of NASA since its inception in 1958 and each student has completed one or two authentic scale models of a rocket, Skylab, the Space Shuttle and the Space Station. Wisner presented Truly with a scale model of Skylab.

In recognition of the students' outstanding efforts to expand their knowledge and understanding of space exploration, Truly presented the school with a framed montage of photos from NASA's Space Shuttle mission 41-G flown in October 1984 whose crew included Canada's first astronaut, Marc Garneau. Also included with the photos were flags of the United States and Canada flown on that Space Shuttle mission.

Truly was in Canada meeting with Dr. Larkin Kerwin, President, Canadian Space Agency, to discuss ongoing cooperative projects. Truly also met with Canada's Minister of Industry, Science and Technology, the Honorable Benoit Bouchard and Canada's Minister of Science, the Honorable William Winegard. ■

Take Pride in America Program Honors Those Who Honor America

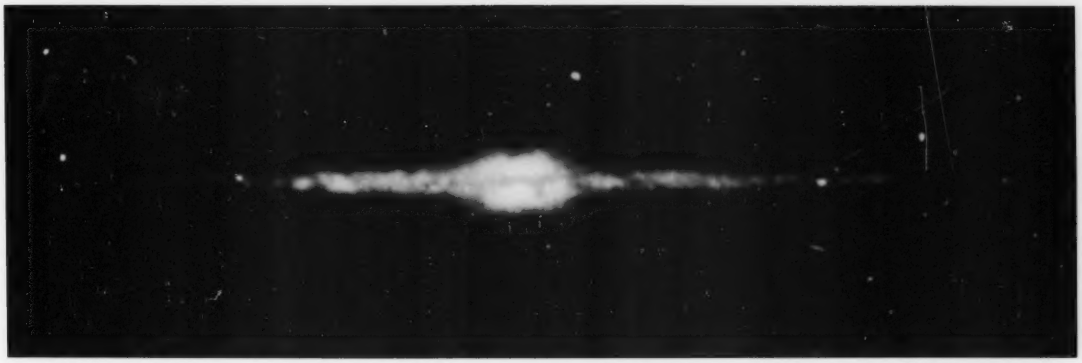
Secretary of the Interior Manuel Lujan, Jr., has announced that President George Bush will honor those citizens who honor America by keeping her beautiful by hosting the third annual Take Pride in America National Awards Ceremony , July 24, on the South Lawn of the White House.

"The individuals and organizations receiving Take Pride awards symbolize America's commitment to volunteerism and stewardship. They have responded enthusiastically to President Bush's call to all Americans to 'join together to protect the glorious but fragile beauties of America, '" Lujan said.

Lending a helping hand to support and publicize the Take Pride in America Campaign, the STS-35 Astro-1 crew wore Take Pride in America t-shirts on their mission exploring the universe.

A Blue Ribbon Panel of Judges selected the 103 most outstanding stewardship activities from among 190 finalists. First Lady Barbara Bush served as Honorary Chairman of the panel, which was co-chaired by Interior Secretary Lujan, Agriculture Secretary Clayton Yeutter, and Education Secretary Lauro Cavazos. Over 530 groups and individuals were nominated for consideration in the National Awards program.

Take Pride in America is a national campaign to: increase awareness of the need for wise use of the Nation's natural and cultural resources, encourage an attitude of stewardship and responsibility toward our natural resources and promote volunteerism. ■



The Milky Way Galaxy is portrayed in this edge-on view obtained by the Diffuse Infrared Background Experiment on NASA's Cosmic Background Explorer (COBE) satellite. Visible is the thin disk and central bulge populations of stars closer to the galactic center than our own Sun, located about 28,000 light years from the core.

Nine Firms Named Excellence Award Finalists

Nine finalists have been chosen for the NASA Excellence Award for Quality and Productivity for 1990. The finalists are:

- Barrios Technology, Inc., Houston
- Bendix Field Engineering Corp., Seabrook, Md.
- Boeing Computer Support Services, Program Support Communications, Marshall Space Flight Center, Huntsville, Ala.
- EG&G Florida, Inc., Kennedy Space Center, Fla.
- Grumman Technical Services Division, Titusville, Fla.
- Honeywell Inc., Space Systems Operations, Clearwater, Fla.
- Marotta Scientific Controls, Inc., Montville, N.J.
- Rockwell International Corp., Space Transportation Systems Div., Downey, Calif.
- Unisys Defense Systems, Space Transportation Operations Contract Program, Houston

Two of the finalists, Barrios and Marotta, will be evaluated in the new small business category established last year by NASA Administrator Richard H. Truly.

This small business category, while following the basic evaluation criteria for larger organizations, permits evaluators to offset the competitive advantage of larger companies with more abundant resources, personnel and funds at their disposal.

George A. Rodney, NASA Associate Administrator for the Office of Safety and Mission Quality, announced the finalists after a 6-month application and review process. Finalists are picked after a review by the Excellence Award Evaluation Committee.

"The award applications are more numerous and getting better each year, making the job of the Evaluation Committee very difficult. A large number of good companies competed this year," said Joyce Jarrett, chairperson of the NASA Excellence Award Evaluation Committee.

The award process now advances to the third phase in which validation teams visit finalists' facilities to verify performance achievements and process attainments.

Following the review and recommendations of the award evaluation teams, NASA's Total Quality Management (TQM) Steering Committee, composed of Center Directors and Headquarters Associate Administrators, will make the final selection of award recipients. The NASA Administrator will announce award recipients at the seventh annual NASA/contractor conference on Oct. 24, 1990. ■

Carnegie-Mellon University Develops Planetary Robot

The "Ambler," a six-legged, 12-foot-tall, prototype, autonomous robot with the "brains" and motor skills to explore rugged terrain, is being developed for NASA by Carnegie-Mellon University's Robotics Institute, Pittsburgh.

NASA officials and university researchers say the Ambler's technology could bring an important new dimension to solar system exploration. Because the robot literally walks, it can traverse rough terrain by stepping over crevices and large boulders.

Future operational rovers, based on the Ambler design, could reach areas on the Moon and Mars inaccessible to wheeled vehicles or too dangerous for humans.

Since October 1987, three teams of researchers including Carnegie-Mellon graduate and undergraduate students have been developing the algorithms, hardware and software necessary for the Ambler's locomotion, perception and planning capabilities.

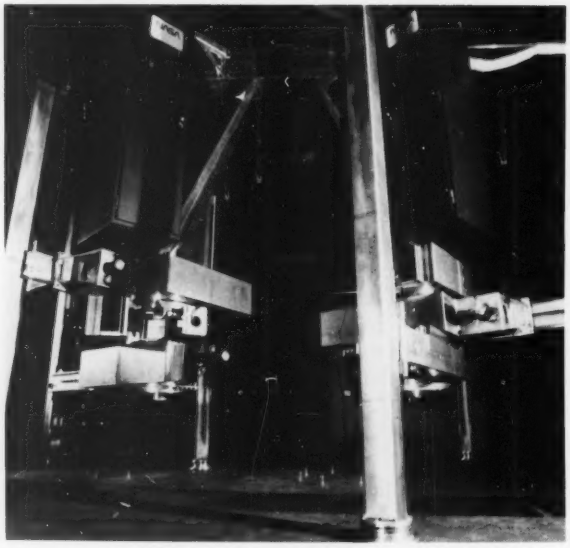
The Ambler represents an integrated, self-sufficient system that will be used to provide NASA mission managers with the confidence that legged vehicles are a realistic alternative to wheeled rovers for lunar and martian exploration.

The aluminum Ambler has two sets of stacked legs, with three legs per stack. These legs separately lift, advance and circulate to their original positions, much like an egg beater.

Because the drive motors that support the Ambler's body are separate from those that propel it, the robot remains level whether it's walking on flat or rugged ground. The design provides a stable platform for sensors, scientific equipment and sample acquisition tools.

Above the legs, on the stacks, are boxes containing the machine's electronics. Above that, a cross bar connects the two sections. The electrically-powered Ambler will be energy efficient and can retain its ability to walk even if it loses mobility in two legs.

The Ambler requires a set of sensors for its vision system. With input from this system, the robot creates three-dimensional maps of the surrounding topography and objects it might be interested in sampling. After studying the maps, it decides in which direction to move and where to place its feet. Future versions deployed on Mars could combine the current laser sensing system with cameras, sonar and other sensors to provide the full spectrum of information needed for sampling and navigation.



The 12-foot high, six-legged Ambler may presage the type of robotic planetary explorers of the future.

The Ambler's unique software control system, called Task Control Architecture, enables the Ambler to plan for the selection of stable and safe steps. "The system is designed for robots that operate in dynamic and uncertain environments," explained principal investigator Thomas Mitchell. "It uses a variety of sensors with different ranges and resolutions to know where it is and see where it's going."

The Ambler recently took its first steps at the Carnegie-Mellon University's Robotics Institute. The next step is integration of its perception, planning and control capabilities.

The Ambler represents a new generation of robots to explore and work in natural terrains. The technology also has implications for Earth-bound activities such as construction, mining, timbering, hazardous waste management and emergency response.

The Ambler is one of the concepts being evaluated under NASA's Planetary Rover program, which is developing robotic and manned technology to explore lunar and planetary surfaces. ■

KSC Prepares Ulysses Spacecraft for Mission to the Sun

By George H. Diller, KSC

A spacecraft that will explore the sun is being prepared for launch at Kennedy Space Center in early October aboard the Space Shuttle Discovery.

Ulysses is a NASA-European Space Agency (ESA) cooperative project to study the sun, the solar wind and interstellar space. The 814-pound spacecraft's instruments will study the phenomena near the sun's north and south polar regions, which never have been examined by spacecraft.

In July, after fueling , Ulysses will be mated with a dual upper stage: a Payload Assist Module coupled to an Inertial Upper Stage.

Ulysses will be carried aboard the Space Shuttle Discovery on mission STS-41, scheduled to be launched from Pad B at Complex 39 on Oct. 5. The launch opportunity extends for 19 days. Discovery is now undergoing preparation for the mission in the KSC orbiter processing facility.

No upper stage propulsion system has enough energy to lift the spacecraft directly from Earth over the sun's poles. Therefore, Ulysses will be launched on an interplanetary trajectory, arriving at Jupiter in February 1992.

Ulysses will use Jupiter's gravity to leave the ecliptic plane and achieve a flight trajectory which will take Ulysses toward the southern pole of the sun. The satellite then will make its first solar polar approach in May 1994.

Ulysses' orbit will cross the sun's equator in February 1995 and continue toward the solar north pole, reaching there in May 1995. The mission will conclude in October 1995, 5 years after launch.

Ulysses undergoing checkout and preparation by KSC personnel.

The science instruments aboard Ulysses are furnished by the United States and Europe. The ESA spacecraft was built by Dornier in the Federal Republic of Germany. The NASA Jet Propulsion Laboratory (JPL), Pasadena, Calif., is managing the U.S portion of the mission. Communications with the spacecraft will be through NASA's Deep Space Network tracking stations, operated by JPL. ■

NASP Contractor Team Announced

The Department of Defense and NASA announced the establishment of a national team of contractors to continue the challenging research and development of the National Aero-Space Plane (NASP).

With the engineering and technology bases available from Rockwell International, McDonnell Douglas, Pratt & Whitney, General Dynamics and Rocketdyne, the federal government expects to benefit from the synergism of ideas from these five organizations.

As a presidentially directed joint DOD/NASA program, the NASP program objective is to develop and demonstrate hypersonic technologies with the ultimate goal of a single-stage-to-orbit vehicle. These vehicles would be capable of horizontal takeoff and landing and long range, hypersonic flight within the atmosphere.

With the national contractor team, DOD and NASA take a unique first step in formulating a single team of contractors working together to develop technologies for future hypersonic aircraft. The team will conduct the design and development activities necessary to proceed with the X-30 research aircraft and develop a competitive technology base for future systems.

Instead of just one contractor coming forward with concepts in materials, propulsion and structures, this new approach will allow the government and the contractors alike to capitalize on five industry bases of technological development.

The government anticipates that with breakthroughs in technology from efforts such as NASP, the United States will continue to maintain its world leadership position in aerospace technology. ■

NASA NEWS CAPSULES

News Capsules are NASA news releases edited by the Internal Communications Branch, Office of Communications.

Consort 3 Launched

Consort 3, a commercial suborbital rocket carrying 12 microgravity materials and biotechnical experiments, was launched May 17 by the University of Alabama-Huntsville's (UAH) Consortium for Materials Development in Space (CMDS), a NASA Center for the Commercial Development of Space (CCDS).

Consort 3 was launched from the Naval Ordnance Missile Test Station facilities at the U.S. Army's White Sands Missile Range, N.M., by Space Services, Inc., Houston, using its Starfire rocket. The rocket carried the payload to an altitude of 200 miles and provided the experiments with 7 to 8 minutes of microgravity time.

The rocket and launch services are funded by a grant from NASA's Office of Commercial Programs, Wash., D.C. Commercial participants provided most of the funding for the payload.

The Consort 3 mission carried experiments from three other NASA commercial development centers. They include the Center for Advanced Materials, Battelle Columbus Laboratories, Columbus, Ohio; the Center for Cell Research, Penn State University, State College; and the Center for Bioserve Space Technologies, University of Colorado, Boulder. ■

Lockheed has recognized Ames-Dryden Chief Pilot William H. Dana for flying the supersonic F-104 Starfighter for over thirty years—"Longest in the fleet." Site Manager Martin A. Knutson (left) holds similar credentials in Lockheed's U-2 high-altitude aircraft.

Marshall Awards Contract to Develop ASRMs

NASA's Marshall Space Flight Center Huntsville, Ala., has awarded an approximately 5-year-long contract to Lockheed Missiles & Space Co., Sunnyvale, Calif., for the design, development, test and evaluation of the Space Shuttle advanced solid rocket motor (ASRM).

The new Shuttle motor will be phased in, during the mid-1990s, as a replacement for the current redesigned solid rocket motor. It will provide improved safety, reliability and performance for the Shuttle flight program well into the 21st Century.

The value of the basic contract is $971 million and calls for production of 20 of the new rocket motors — one as a nonflying, form-and-fit "pathfinder," seven for ground test-firing and qualification, and 12 (6 flight sets) for Shuttle launches.

Under an option for production of additional ASRM flight motors, NASA could order up to 88 motors (44 sets) to support the Shuttle flight program. The additional production option could be valued at up to $1.388 billion if the maximum of 88 motors is purchased.

Lockheed is teamed with Aerojet Space Boosters Co., Sacramento, Calif., as its principal subcontractor for development of the advanced motor, and with Rust International, Birmingham, Ala., as the facility construction contractor. ■

Two MACSATS Launched by NASA

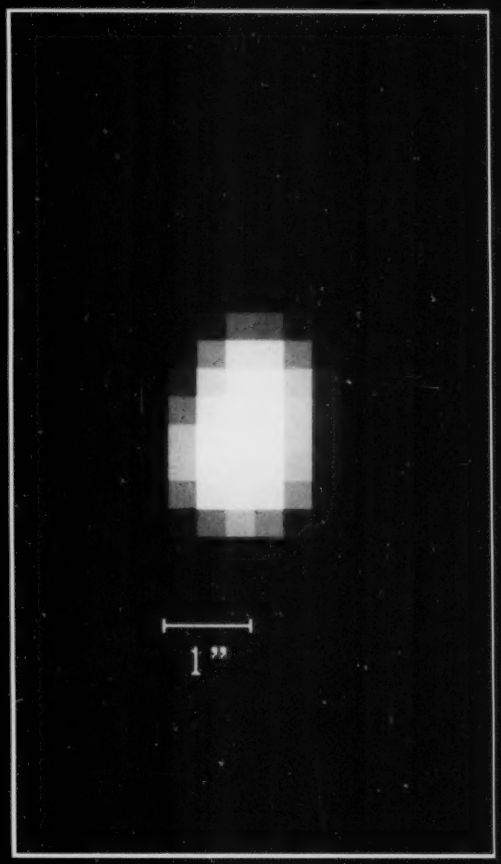
Two Multiple Access Communications Satellites (MACSATs) were launched by NASA aboard a Navy-owned Scout rocket May 9 from Vandenberg Air Force Base, Calif. The program is sponsored by the Department of Defense Advanced Research Projects Agency (DARPA).

The MACSATs, developed by Defense Systems Inc., will provide a global store-and-forward message relay capability at UHF frequencies for a variety of Department of Defense users during test demonstrations to be conducted this year by DARPA.

The Scout program is managed by NASA's Langley Research Center, Hampton, Va. The 73-foot-long, four stage, solid-propellant rocket motor launch vehicle is built by the Missiles Division of LTV Missiles and Electronics Group, Dallas, Texas.

First launched in 1960, Scout has had 98 successful missions in 112 attempts, including 56 successes in 57 launches since 1967. ■

Hubble First Light Images Sharp



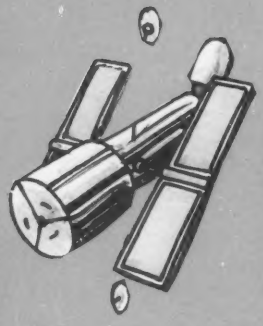
GROUND BASED IMAGE
LAS CAMPANAS OBSERVATORY
CARNEGIE INST. OF WASHINGTON

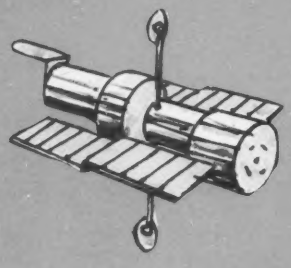
HUBBLE SPACE TELESCOPE
WIDE FIELD/PLANETARY CAMERA

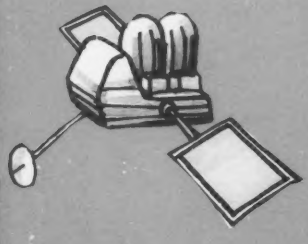
On the right is part of the first image taken with NASA's Hubble Space Telescope's (HST) Wide Field Planetary Camera. It is shown with a ground-based picture from Las Campanas, Chile, Observatory of the same region of the sky. The Las Campanas picture was taken with a 100-inch telescope and is typical of high quality pictures obtained from the ground. All objects seen are stars within the Milky Way galaxy. The images of the stars in the ground-based picture are fuzzy and overlapping, because of smearing by the Earth's atmosphere. The same stars in the HST frame are sharper and well resolved, as shown by the double star at the center of the image. By avoiding the Earth's atmosphere, the HST gives sharper images and better resolution. In the early engineering picture, the HST images were roughly 50 percent sharper.

NASA's Great

Expanding Scientific Perception







Astronomical searches have occupied human thought for millennia. Over the generations, we have succeeded in gaining ever greater insight into the underlying forces at work in the cosmos. In the Space Station era, the family of permanent observatories in space will open the way to new, comprehensive studies of key remaining problems in astrophysics, helping us understand:

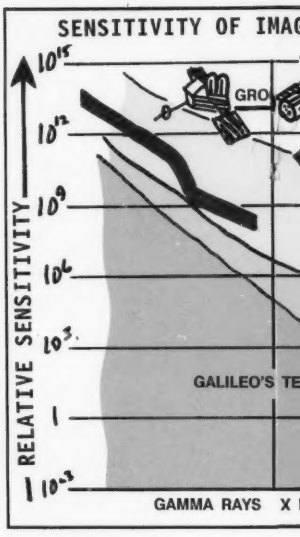
- The birth of the universe, its large-scale structure, and the formation of galaxies and clusters of galaxies;
- The fundamental laws of physics governing cosmic processes and events;
- The origin and evolution of stars, planetary systems, life and intelligence.

If we succeed, we will leave a legacy to rank us with the great civilizations of the past.

NASA's Role

NASA's major contribution to modern astrophysics has been the agency's ability to place powerful new telescopes into orbit. From their vantage point in space, these observatories can sense gamma rays, X-rays, and ultraviolet, optical, and infrared radiation undisturbed by the distorting, absorbing atmosphere.

Discoveries of ultra-hot gas in clusters of galaxies, gamma background-radiation from the universe, and galaxies which emit virtually all their energy in the infrared have all resulted from this capability. Observations in each wavelength band reveal a new universe.

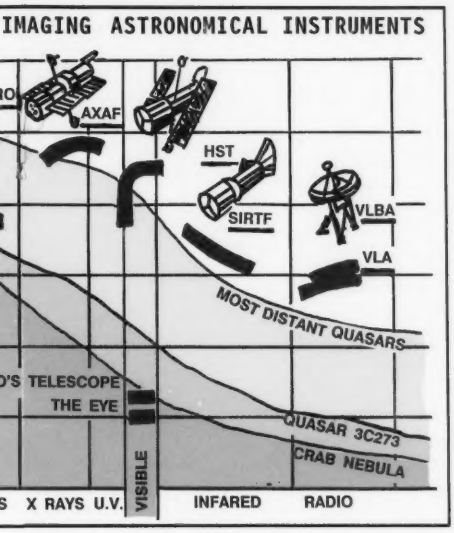


Over the past two decades, NASA has introduced increasingly sensitive instruments into space. In astronomy, families of telescopes have been developed and placed in orbit for observations across the entire electromagnetic spectrum, especially those parts blocked by the atmosphere.

Each successive telescope has extended the limits of sensitivity and provided greater insight into the structure of stars, galaxies, and the cosmos. For these successes, new technologies had to be created and exploited. Members of the new generation of space observatories offer significant new gains in sensitivity through state-of-the-art technology.

- **The Gamma Ray Observatory (GRO)** will explore the most energetic part of the spectrum across a much greater wavelength range than its predecessors.
- **The Advanced X-Ray Astrophysics Facility (AXAF)** will cover the X-ray portion of the spectrum with a hundred-fold improvement in sensitivity.

Observatories
for Understanding the Universe



•**The Hubble Space Telescope (HST)** will penetrate deep into the universe in visible and ultraviolet light, expanding the volume of observable space several hundred times.

•**The Space Infrared Telescope Facility (SIRTF)** will span the infrared part of the spectrum with a thousand-fold increase in sensitivity.

To complement these sensitive space telescopes, the astronomical community is currently considering two powerful new ground-based observatories: the Very Long Baseline Array (VLBA), an intercontinental network of radio telescopes, and the National New Technology Telescope (NNTT), a large optical telescope. In addition, NASA's Solar Optical Telescope (SOT) will provide detailed data on our nearest star, the sun, to augment our studies of distant stars and cosmic processes.

With these new observatories, we will be able to open more of the universe to scrutiny, to look back in time and space for order and meaning.

Techno Future

Astronomical observations pose some of the greatest challenges to modern technology. Engineering difficulties overcome by astrophysicists often provide solutions to more general technical problems. We expect new technologies developed for our space observatories to stimulate future applications in space and on Earth.

•**GRO** introduces a propulsion system that can be refueled in orbit to extend the lifetime of the observatory.

•**AXAF's** nested grazing-incidence mirrors will provide the most advanced X-ray focussing optics presently known. Previous X-ray astronomical advances have already led to commercial applications in low-dosage imaging systems.

•**HST** has already pioneered the construction of higher precision optics than any ever built. Its spacecraft pointing control will cross new thresholds of accuracy.

•**SIRTF** will provide longer endurance for ultra-low-temperature apparatus in space, a requirement for many other high-precision technologies. Previous infrared astronomical missions pioneered the handling of liquid helium, the ultimate refrigerant, in space. However, SIRTF introduces the new capability of replenishing liquid helium coolant in orbit.

These advanced technologies will be of benefit not only for scientific research but also for practical down-to-Earth uses. We can only guess what new applications will result from the spread of these technologies into everyday life.

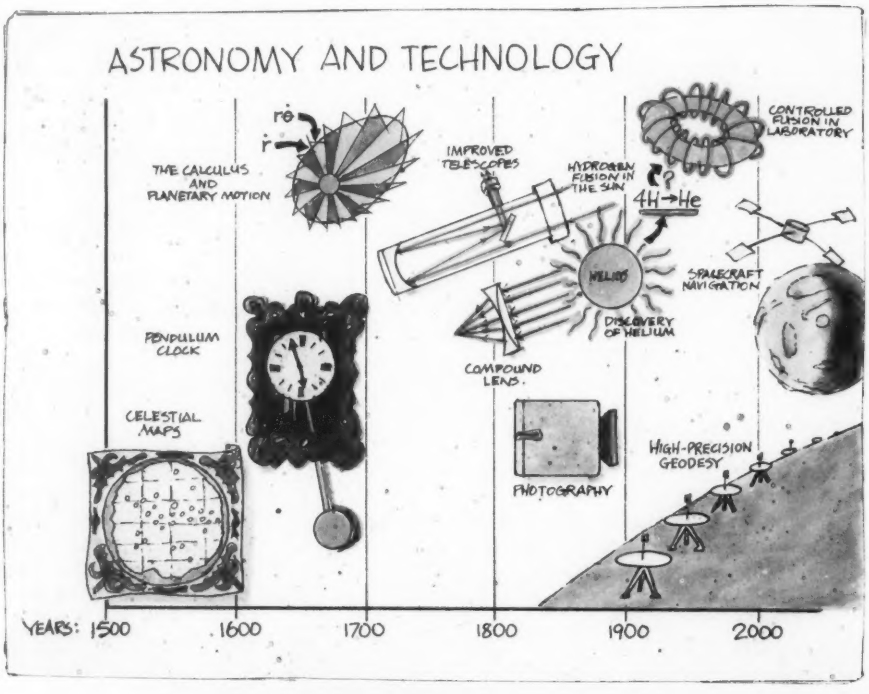
AT WORK—Hubble team members concentrate on telemetry downlink during observatory deployment.

Astronomy and Technical Cross-fertilization

Over the centuries, astronomy and technology have progressed hand in hand. The study of the universe has benefited from improved observational devices and techniques. By the same token, developments in astronomy have led to practical applications in other disciplines.

1500-1600
- Increasingly accurate maps of the sky for navigation

1600-1700
- Christian Huygen's invention of the pendulum clock for navigational time keeping
- Newton's development of the calculus, the laws of motion and the law of universal gravitation as a means to explain the motions of planets and comets



1800-1900
- Increasingly sophisticated optical innovations by astronomers (William Herschel, Fraunhofer, Lord Rosse, Alvan Clark, and many others)
- Development of increasingly sensitive photographic techniques
- Lockyer's discovery of a new chemical element, helium, on the sun before it was known on Earth

1900-NOW
- Hans Bethe's theoretical prediction of hydrogen fusion at the center of the sun, a precursor for all modern fusion efforts
- Lyman Spitzer's development of astrophysical plasma theory, the basis of present devices for releasing energy from controlled fusion
- Very long baseline radio astronomy techniques used in high-precision geodesy to survey the structure of the Earth
- Techniques of celestial mechanics, precursors to the development of accurate spacecraft navigation.

The mutually beneficial interaction between astrophysics and technology continues today. ■

A Perspective of the Search

Astronomical searches have occupied human thought for millennia. Over the generations, we have succeeded in gaining ever greater insight into the underlying forces at work in the cosmos. In the Space Station era, the family of permanent observatories in space will open the way to new, comprehensive studies of key remaining problems in astrophysics, helping us understand:

- The birth of the universe, its large-scale structure, and the formation of galaxies and clusters of galaxies;
- The fundamental laws of physics governing cosmic processes and events;
- The origin and evolution of stars, planetary systems, life and intelligence.

If we succeed, we will leave a legacy to rank us with the great civilizations of the past.

F-16XL Aircraft Laminar Flow Studies Set to Begin at Dryden

By Don Haley, DFRF

Flight testing of the first experimental wing surface designed to improve laminar (smooth) airflow at supersonic speeds has begun at NASA's Ames-Dryden Flight Research Facility, Edwards, Calif.

The flights with a specially-modified F-16XL aircraft are part of an effort to improve high-speed performance by reducing aerodynamic drag. Current aircraft designs, both subsonic and supersonic, have turbulent airflow over a major portion of their wings. This turbulence decreases performance and reduces fuel efficiency. Good laminar flow occurs when the turbulent layers of air flowing over an aircraft wing in flight are minimized.

A thin experimental wing section containing an active suction system has been placed on the upper surface of the F-16XL's wing. Designed by Rockwell International, North American Aircraft, El Segundo, Calif., the "glove," as it's commonly called, is intended to siphon-off a portion of the layer of turbulent surface air through millions of tiny laser-cut holes in the experimental section's titanium skin and provide a greater area of smooth airflow over that section of the wing.

Researchers expect the instrumentation monitoring airflow over the experimental wing section to produce data that will validate computer codes and aid in the design of future high-speed civil transports and high-performance military aircraft.

NASA research pilot Steve Ishmael will make about 20 flights over the next 3 months to evaluate the laminar flow wing section at supersonic speeds.

An F-16XL flown by Ames-Dryden Flight Research Facility tests supersonic laminar flow.

According to Louis L. Steers, manager of the F-16XL project at Ames-Dryden, NASA also plans subsequent laminar flow studies with a different type of experimental wing surface designed by NASA's Langley Research Center, Hampton, Va. ■

X-29 Shows Unexpected Maneuverability

The X-29 research aircraft is demonstrating in flight much better control and maneuvering qualities at high angles of attack than predicted by wind tunnel tests, computational methods and simulation models.

The X-29 is an advanced technology demonstrator aircraft based at Ames-Dryden Flight Research Facility, Edwards, Calif. The current flights, using the second of two X-29s, are investigating high angle of attack characteristics and military utility of the aircraft's unique forward swept wing/canard configuration as part of a joint NASA-Air Force program.

Angle of attack is an engineering term that describes the angle of an aircraft's body and wings relative to its actual flight path. At extreme angles of attack, the airflow around an aircraft can produce conditions in which the wings do not create enough lift to maintain altitude.

According to Steve Ishmael, one of NASA's X-29 project pilots, the aircraft's excellent control response in the 25-45 degree angle of attack range was unexpected. "We have much more control than we thought we would have at these angles," said Ishmael. "We have good roll control and we have modest yaw control."

Possible explanations include interaction of the canards with vortices of air coming off the nose or some unexpected effect of the plane's forward-swept wings.

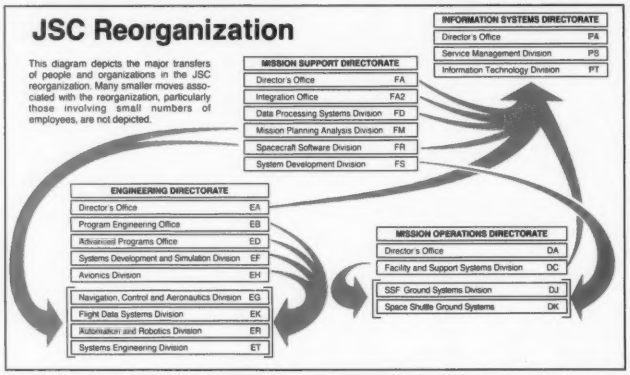
Said Gary Trippensee, X-29 project manager at Ames-Dryden, "It's something we're really looking forward to exploring." ■

Lines Drawn for JSC'S New Organization

By Kelly O. Humphries, JSC

The lines for JSC's new organizational chart have been drawn, but Director Aaron Cohen says he expects additional refinements. Cohen approved the plan, which reorganizes Mission Support, Mission Operations and Engineering Directorates, March 30.

"My main aim in making these changes is to resolve two unnatural splits that have been impeding the effectiveness of our center," Cohen said. "First, we needed to put the responsibilities for flight hardware and software in the same hands. Second, we needed to put the job of developing mission support systems and ground facilities in the hands of the users."


JSC Reorganization
This diagram depicts the major transfers of people and organizations in the JSC reorganization. Many smaller moves associated with the reorganization, particularly those involving small numbers of employees, are not depicted.
INFORMATION SYSTEMS DIRECTORATE
Director's Office PA
Service Management Division PS
Information Technology Division PT
MISSION SUPPORT DIRECTORATE
Director's Office FA
Integration Office FA2
Data Processing Systems Division FD
Mission Planning Analysis Division FM
Spacecraft Software Division FR
System Development Division FS
ENGINEERING DIRECTORATE
Director's Office EA
Program Engineering Office EB
Advanced Programs Office ED
Systems Development and Simulation Division EF
Avionics Division EH
Navigation, Control and Aeronautics Division EG
Flight Data Systems Division EK
Automation and Robotics Division ER
Systems Engineering Division ET
MISSION OPERATIONS DIRECTORATE
Director's Office DA
Facility and Support Systems Division DC
SSF Ground Systems Division DJ
Space Shuttle Ground Systems DK

A third objective was to set the stage for long-term productivity improvement and cost savings by creating an organization dedicated to developing and coordinating all of JSC's institutional information and communications services.

"JSC's separate organizations have grown by leaps and bounds in information technology, but coordination has been lacking. To make the most cost-effective use of these systems, we need an organization that takes a centerwide approach," Cohen explained. Adjustments are likely to continue in the next several months, he said.

The most obvious organizational change is the establishment of the Information Systems Directorate (Code PA) from the parts of the old Mission Support Directorate that dealt with information resources across the center, such as the Data Processing Systems Division. Other major portions of MSD have been divided between Engineering and Mission Operations in an effort to combine management responsibility for flight hardware and software and put ground systems development responsibility with the users.

The new Information Systems Directorate (ISD)—made up of the old MSD's Data Processing Systems Division (FD), a branch from the Flight Software Division (FR), the Integration Office (FA) and various computer experts from MOD and ENG—will put together and follow through on a set of consistent centerwide information services.

Engineering Director Henry Pohl is taking advantage of the opportunity to make some additional changes in ENG that complement Cohen's overall plan. In all, six divisions have been abolished and replaced with four.

The Program Engineering Office (EB), Advanced Programs Office (ED), Systems Development and Simulation Division (EF), Avionics Systems Division (EH), Mission Planning and Analysis Division (FS) and Flight Software Division (FR) are now gone.

In their place are the Navigation, Control and Aeronautics Division (EG), the Flight Data Systems Division (EK), Automation and Robotics Division (ER) and Systems Engineering Division (ET).

Creation of the first two, EG and EK, is specifically aimed at the major reorganization goal of locating flight hardware and software responsibilities in the same directorate. The birth of (ER) has its roots in Cohen's desire to provide a division-level focus for automation and robotics. And the formation of ET is designed to better focus the center's ability to support multiple major programs concurrently.

Moving the Systems Development Division (FS) from MSD to MOD and combining it with the MOD Facilities and Support Division (DC) will fulfill another of the reorganization's major goals by giving responsibility for development, maintenance and operation of ground facilities and systems to the users. The old divisions have been abolished and two new divisions, aligned by program, have been created to accept those responsibilities.

The Space Station Freedom Ground Systems Division (DJ) will be responsible for development of new facilities for mission operations and training that will continue through sustaining engineering, maintenance and operations. The Space Shuttle Ground Systems Division (DK) will be responsible for upgrades, sustaining engineering, maintenance and operations for shuttle facilities. ■

Ames Unveils Human Performance Research Lab

By Donald G. James, ARC

Ames Research Center has unveiled its latest research laboratory designed to answer fundamental questions about long-term human space flight and to expand our knowledge of human factors in the nation's increasingly crowded airspace system.

The Human Performance Research Laboratory (HPRL) at NASA's Ames Research Center, Mountain View, Calif., is the first U.S. facility designed and built to study the human role in advanced aviation and prolonged space travel.

Speaking at the dedication ceremonies, Ames Center Director Dale Compton said that the HPRL "will help scientists answer questions about the relationship between humans and complex machinery. Ambitious space goals, like a lunar outpost, a Mars expedition or the National Aero-Space Plane, depend on a better understanding of how humans will interact with machines in these missions."

Among the specialized laboratories and test facilities to be included in the HPRL are those dedicated to development of virtual environment workstations, computational vision and advanced rotorcraft displays. The HPRL also will contain a unique design facility for the U.S. Army/NASA Aircrew-Aircraft Integration program.

Compton, together with special guests, also broke ground for the new $8.6 million, 59,000 sq. ft. Automation Sciences Research Facility (ASRF) in the ceremonies. The ASRF, scheduled for completion in January 1992, will provide laboratories to conduct research and technology development in automation and artificial intelligence.

Ames Human Performance Research Lab adjacent to the Center's 80 x 120 wind tunnel.

Compton said, "the decision to locate the Automation Sciences Research Facility and Human Performance Research Laboratory in a single complex recognizes that artificial intelligence (AI) and human factors research complement each other. A productive relationship between humans and machines is critical in the aerospace program."

One question these laboratories will address is how humans will travel to Mars and return to Earth safely. During the long trip to Mars, astronauts must rely more on automated systems to make critical launch and mission operations decisions. ■

Effects of Tropical-Forest Burning

By Diane Stanley, ARC

Cattle pastures that were once Brazilian tropical forests may be contributing to the buildup of greenhouse gases in the atmosphere, NASA scientists report.

A team headed by Dr. Pamela Matson of Ames Research Center, Moffett Field, Calif., sampled nitrous oxide levels in three ecosystems within Brazil's Amazon Basin: undisturbed rain forests, recently cleared and burned areas and land converted to cattle pastures.

The researchers found that nitrous oxide emissions from recently cleared areas were not significantly higher than those from undisturbed rain forest. However, annual emissions from pastures were three times as high as levels obtained from representative samples of tropical forest.

Nitrous oxide is a greenhouse gas, trapping heat close to the Earth's surface that would otherwise radiate into space. Various studies have shown nitrous oxide concentrations in the atmosphere are increasing by 0.2 to 0.3 percent each year, but investigators, studying global climate, have been unable to explain the increase.

"This is the first study showing the potential importance of tropical land use changes on greenhouse gases other than carbon dioxide," said Dr. Matson. "Given that tropical deforestation is occurring so rapidly, this effect could have global significance."

The findings were reported by researchers for NASA's Ames Research Center, Moffett Field, Calif.; Brazil's Institute for Research in the Amazon; and Stanford University, Palo Alto, Calif. ■

Langley Engineers and Marine Scientists Test Bay Clean-Up Technology

By Jean Drummond Clough and Craig E. Murdon, LaRC

New vitality may come to the Chesapeake Bay as a result of a pilot program to improve the bay's water quality. Through a unique blend of marine science and aerodynamic research, the Virginia Institute of Marine Science (VIMS) and the NASA Langley Research Center, Hampton, Va., have joined forces in project "Water Wings."

The project began when marine scientists at VIMS confronted the problems of serious damage to marine life from low levels of oxygen in some bottom regions of the bay. This condition occurs during the summer when low saline water forms a fixed or stratified layer over denser, saltier water just as atmospheric inversions capture smog in major cities. In this case, the denser layer of water stops oxygen from moving downward. Organic decay uses up the remaining lower level oxygen creating an environment hostile to most aquatic life and impeding continuation of the food chain. Oysters are most sensitive to this problem.

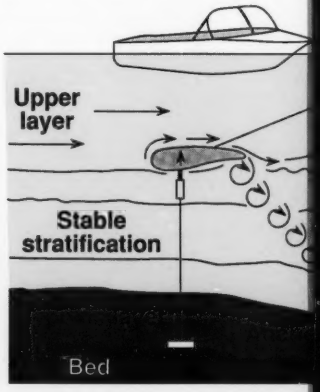
In seeking a solution, Professor Don Wright, head of the VIMS Division of Geological and Benthic Oceanography, and his colleagues looked for a way to generate turbulence at the point of stratification so that the oxygen-rich water could move downward to replenish the bottom supply. Their proposals focused on the use of tornado-like flow patterns, called vortices, which form behind aircraft wings. These vortices are often observed as familiar contrails behind high flying aircraft where ice crystals make the swirling patterns visible.

After initial consultation with Dennis Bushnell, associate chief of Langley's Fluid Mechanics Division, the VIMS scientists were referred to research engineer George Greene, NASA's authority on aircraft wake vortices. Together, they began looking at the feasibility of placing an underwater aerodynamic structure, like a wing, at the stratification level. Designed to always be oriented to the tidal current, the "water wing" would use the flow of tidal water instead of air to create the same tornado-like turbulence as from an airplane. This action would break up the stratified boundary layer and achieve the desired oxygen dispersal to the bottom.

Twenty-foot water wing is deployed by researchers near Langley.

Greene says the first step of the feasibility project was to capitalize on the large amount of research done by NASA Langley in its Wake Vortex Research Program. This effort had already made significant contributions to problems involving vortex effects on airliners in congested airport environments and, in particular, in determining how vortices behave in stratified air layers. The challenge was to spin-off these results to the underwater environment in the most uncomplicated and inexpensive way. The initial effort was a simple, straight, wooden wing similar to those used on small, light aircraft. Initial testing was in the York River, Va.

The York River was chosen as the first test site because of its proximity to both agencies and the bay, and because its current, bottom contours and flow characteristics are well known to the VIMS scientists. The first deployment, which was monitored by both divers and underwater instrumentation, was very successful, according to Wright. The vortex turbulence created by the flow of water over the wing was conclu-

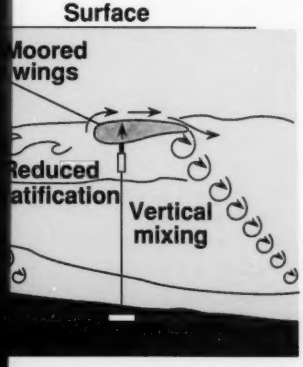


sively demonstrated and, as a result, a revised, second phase configuration was prepared for testing.

That is where the project now stands. The current shape is a swept-wing design, 20-feet long with a 4-foot chord. Its testing will continue through the summer of 1990 and those results will herald a third and more ambitious stage when multiple arrays of wings will be used to treat large areas to conclude the feasibility portion of the test program.

Both Wright and Greene are optimistic about the concept as testing continues. As Greene points out, "the taxpayer has already paid for the NASA research and its highly beneficial application to commercial aviation safety. The fact that we can now use the same results in a new and exciting environmental venture makes the basic work we've done at Langley all the more worthwhile."

Wright states that the technology capitalizes on the natural energy of water currents which, "gives us greater flexibility for eventual deployment options throughout the bay." He visualizes widespread placement of the wings in virtually any part of the bay and its tributaries where there is sufficient water depth and tidal current. "Of course they'd be out of main channels and carefully marked with their own distinctive buoys," he adds. ■



"Antique" Crawler Transporter—Low Miles/ Used only for trips to beach and back.

Kennedy Space Center's Crawler Transporter No. 2 could qualify for a Florida antique automobile tag. But the 25-year-old, 3,000 ton vehicle just passed its first 1,000 mile landmark as it carried the Space Shuttle Columbia to Pad 39-A for launch on the STS-35 mission.

The twin crawler transporters are vital links in the launch processing chain. They provide the means by which the launch vehicle atop its massive mobile launch platform is transferred from the Vehicle Assembly Building to the launch pad.

During its slow roll to reach the 1,000 mile marker, transporter 2 has been operated by 10 different drivers. It has supported Apollo, Skylab and Space Shuttle missions and provided service to the nation's space effort in the four decades from the 1960s into the 1990s. Crawler Transporter No. 1 is not far behind in accumulated mileage; it lacks approximately 25 miles toreach the 1,000-mile mark.

Early concepts of transporting launch vehicles to the pads included a barge and canal system, a rail system, and the land transporter. The task of transforming one of these concepts into reality fell to Donald D. Buchanan, then Chief of the Launcher Systems and Umbilical Tower Design Section. Now retired, Buchanan lives within sight of KSC at nearby Titusville.

"The crawler transporter was the dark horse of the concepts being considered," Buchanan said. "But eventually the barge/canal concept proved too unstable and the rail system more costly and inflexible due to the loads it would be required to carry."

Following a year of study, NASA decided in 1962 that the cross-land tracked vehicle, or crawler transporter, would be the most feasible means of moving the launch vehicle to the pads. An ambitious task was ahead. Large volumes of soggy land had to be moved and a heavy-duty crawlerway built. The goal: build a system capable of moving the largest structures ever to be moved on land and move them several miles in a reasonable amount of time.

"At the time," Buchanan said, "no one dreamed something that moved so slow would ever reach 1,000 miles."

In 1963 the Marion Power Shovel Company, Marion, Ohio, was awarded the contract to build two crawler transporters. When built, the transporters dwarfed the self-propelled, strip-mining shovels after which they were patterned. The transporters were assembled in 1965-66. The cost of both transporters was under $15 million. ■

NASA STORY

(NASA STORY is written by members of the NASA History Division)

Apollo-Soyuz Test Project

By William S. Skerrett, Hq

Stafford: "Contact!"
Leonov: "Capture!"
Stafford: "We also have capture...we have succeeded.
Leonov: "Soyuz and Apollo are shaking hands now."
Stafford: "We agree."
Leonov: "Well done, Tom, it was a good show. We're looking forward now to shaking hands with you on board Soyuz."
Stafford: "Thank you, Aleksei. Thank you very much to you and Valeri."

At 12:09 pm EDT, July 17, 1975, the world watched a United States Apollo spacecraft dock with a Soviet Soyuz spacecraft. It was the culmination of five years of planning, negotiating, developing, and training for the first international cooperative manned space mission. After twenty years of fierce competition,the two super powers joined hands and minds to complete what was to be known as the Apollo-Soyuz Test Project (ASTP). The Apollo-Soyuz docking was one of the greatest accomplishments for either nation, second only to Yuri Gagarin's first manned space flight and the Apollo 11 Lunar landing.

The idea for a joint mission originated shortly before the first Apollo Lunar landing. NASA managers planning post-Apollo missions suggested a US/Soviet space rescue test operation. In April 1970, then NASA Administrator Thomas O. Paine met with Soviet Academician Anatoliy A. Blagonravov to discuss joint cooperation in developing a compatible docking system for space rescue missions. An agreement was signed in October establishing three working groups to begin design work for an international docking mechanism. Further arrangements continued over the next two years, and on May 24, 1972, President Richard M. Nixon

and Premier Aleksei N. Kosygin signed the Agreement Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes. Article three of the agreement officially established the ground work for the joint mission, and a complete project schedule was instituted for a test flight of a docking system in 1975.

On January 30, 1973 NASA announced the assignment of the prime crew - Thomas P. Stafford, mission commander; Vance D. Brand, command module pilot; and Donald K. "Deke" Slayton, docking module pilot. Four months later the Soviets announced the Soyuz crew of Aleksei A. Leonov, commander, and Valeri N. Kubasov, flight engineer.

The main objective of the mission was to design a common docking mechanism but a major obstacle in meeting this objective was the incompatibility of the Apollo and Soyuz spacecraft environments. The Apollo spacecraft used a one third sea-level pressure with pure oxygen while the Soyuz had an oxygen-nitrogen mix at sea-level pressure. An entire new unit, known as the docking module (DM), was designed to act as an airlock between the two spacecraft to allow the transfer of the crews.

Engineers from both countries still expressed concerns related to the environment of the spacecraft. The Soviets, remembering the sudden decompression during the reentry of Soyuz 11 killing three cosmonauts, were worried about pressure integrity. The United States, remembering the Apollo 11 fire,which also killed three astronauts, were concerned about the flammability of the Soyuz craft. Concessions were made, and highly sensitive pressure gauges were designed for the docking module, and the Soviets developed a fire retardant material for the Soyuz spacecraft.

The docking module, constructed by Rockwell International, consisted of two different docking mechanisms at each end. One end of the module used the mechanisms originally designed for the Apollo spacecraft and the Lunar Module (LM), while the other used the Soyuz docking mechanism

originally designed for space rescue missions. The complete Apollo-docking module-Soyuz assembly was 20 meters long and weighed 21 tons.

On July 15, 1975 both countries readied for launch. At 8:20 a.m. EDT (5:20 p.m. Moscow time) Soyuz 19 was launched from Biakonur Cosmodrome. On the third orbit the Soviet crew gained-communications with Houston mission control, thereby establishing the Moscow-Houston-Soyuz-Apollo communications link. Seven hours after the Soyuz launch, the Saturn 1B launch vehicle roared from the launch pad at the Kennedy Space Center.

In orbit the docking module was released and the Apollo spacecraft turned and docked with it. The Apollo and Soyuz spacecraft performed maneuvers in preparation for rendezvous. Shortly after Apollo made its last course correction communications between the spacecraft were established. At 12:09 July 17, the two spacecraft docked over the Atlantic Ocean off the coast of Portugal, and at 3:17 p.m. the Soyuz hatch was opened and Leonov and Kubasov welcomed Stafford and Slayton into the Soyuz spacecraft.

Ceremonies began with congratulatory remarks from President Gerald Ford and Communist Party General Secretary Leonid I. Brezhnev. Commemorative items were signed and exchanged, and after a meal aboard Soyuz, Slayton and Stafford rejoined Brand in the Apollo capsule.

The second day consisted of many experiments and television transmissions as crew members took turns transferring from each capsule. At 4:49 p.m. EDT July 18, the crews returned to their respective spacecraft and the hatches were closed for the last time. Total time of the crew transfers was 19 hours and 55 minutes with five joint

continued on page 22

BIOGRAPHY

(Biography is written by members of the NASA History Division)

Nancy G. Roman: NASA Astronomer

By Sarah H. Turner, Hq

Eternally circling the Sun between the Mars and Jupiter, the minor planet bears the name of a NASA Chief Astronomer, honoring her works. Who was she?

The answer: Dr. Nancy G. Roman, NASA's Chief Astronomer from 1959 to 1979.

Roman developed an early interest in astronomy and by 1955 she had been named to the faculty at the University of Chicago, Yerkes Observatory and had moved on to the Radio Astronomy Branch of the Naval Research Laboratory, where she worked on the spectra of radio stars, the galactic distribution of radio emissions, and radar measurement of the distance to the Moon.

Offered in 1959, the chance to develop the NASA astronomy program, a program that would have wide reaching affects on the field of astronomy, she could not turn it down.

In March 1959, Roman joined NASA as Head of the Observational Astronomy Program. She became Chief of the Astronomy and Relativity Programs in the Office of Space Sciences in 1960 and remained until her retirement 1979.

It was her responsibility to act as liaison between the astronomers, the engineers, and the government in planning experiments and programs to study the sun, planets, stars, galaxies, and the earth's gravitational field.

She also had scientific responsibility for the Orbiting Astronomical Observatory, Orbiting Solar Observatory, and the Geodetic Satellite programs.

Roman's first major project at NASA was coordinating the Orbiting Astronomical Observatory program. Several astronomers surveyed expressed the need to observe the sun, planets and stars from outside the disturbing influence of the earth's atmosphere and by1959, plans were under way for the first in a series of Orbiting Astronomical Observatories.

First attempts to launch an observatory ended in failure but in 1966, OAO-2 was successfully launched and deployed. It has been estimated that the knowledge gained in one month from OAO-2 was greater than that acquired in the previous 400 years.

During this same time period discussion began on plans for a Large Orbital Telescope. Concerned with the technological problems and cost of such an instrument, she cautioned NASA and the National Science Foundation not to take on such a large project but recommended that more feasibility studies be done. As the Hubble Space Telescope became more of a reality, Roman became a supporter and played an important part in winning approval for the telescope. The Hubble Space Telescope was launched on from Kennedy Space Center on April 24, 1990, aboard the Space Shuttle Discovery (STS-31).

Of all the projects Roman was involved with, she is most proud of the International Ultraviolet Explorer (IUE). Designed to

continued on page 22

Apollo-Soyuz,
from page 21

experiments.

On July 19 at 8:02 a.m. EDT, the two spacecraft separated. The Apollo spacecraft then maneuvered to eclipse the sun, allowing the Soyuz crew to photograph the solar corona. A short time later, over the Mediterranean Sea, the two spacecraft docked a second time. The spacecraft separated and maneuvered into separate trajectories at 11:26 a.m.

The Soyuz crew landed at 6:51 a.m. EDT, July 21, after a 142 hour, 31 minute mission. The Apollo crew remained in orbit to carry out additional experiments.

At 3:45 p.m. EDT, July 23, the command module separated from the docking module and began the reentry sequence. During reentry a mishap caused toxic fumes to vent into the capsule causing eye and lung irritations to the astronauts. The astronauts landed safely at 5:18 p.m., July 24, though post-flight activities were cancelled.

Though a success, many Americans criticized the mission as another costly space stunt. However, Apollo-Soyuz cannot be defined simply in dollars. The mission not only developed an international space rescue capability, but more importantly laid the ground work for future cooperation between the United States and Soviet Union. ■

Roman,
from page 21

functionally resemble a ground-based observatory, the international IUE hadthe primary goal of exploring the ultraviolet spectral region. Launched in 1977, it is still active twelve years later. Since its launch the IUE has been credited with the discovery of galactic halos (hot gas which surrounds our galaxy), monitored volcanic activities on one of Jupiter's moons, beamed back the first space recorded images of Halley's Comet, and monitored the intense ultraviolet radiation from a Supernova.

Roman retired from NASA in 1979 but continues to serve as a consultant for the Agency.

In 1985, the International Astronomical Union announced the naming of a minor planet in her honor. The planet, Roman, is located in the asteroid belt between Mars and Jupiter.

Once during her tenure at NASA someone asked Roman if she missed astronomy. Roman replied that she "had never left astronomy only research" and that she had done much more for astronomy by working for NASA than she could have ever achieved through research. ■

HUMAN FACTORS

Townsend to Retire, Truly Appoints Klineberg Director of Goddard

Klineberg

NASA Administrator Richard H. Truly has announced the appointment of Dr. John Klineberg as director of Goddard Space Flight Center, Greenbelt, Md., effective July 1, 1990. Klineberg will succeed Dr. John Townsend, who announced his planned retirement effective June 30, 1990.

Klineberg, a 20-year NASA veteran, has been director of Lewis Research Center, Cleveland, for the past 3 years.

Truly, commenting on the appointment said, "We are fortunate to have on our management team a man of Dr. Klineberg's experience and ability to take over this challenging assignment at a time when Goddard Space Flight Center is at the heart of so many of NASA's science programs, both in flight now and planned for the next few years."

Truly paid tribute to Townsend for his long career in government service. "Jack Townsend exemplifies the best in government servants," said Truly. "He came back to NASA in June of 1987 to help out in the post-Challenger recovery period after a distinguished career in a number of positions at NASA and in other government agencies. As he departs 33 years of distinguished public service, all of us at NASA wish him the best in his years ahead."

Klineberg joined NASA 20 years ago at Ames Research Center, Moffett Field, Calif. In 1974, he moved to NASA Headquarters, Washington, D.C., as head of the low speed aircraft branch, OAST, rising to deputy associate administrator. He was assigned to Lewis as deputy director in 1979 and was named director in 1987.

KSC's Merrilees Named Admiral

Kennedy Space Center Payloads Resources office program analyst Bob Merrilees has been named one of two U.S. Coast Guard Reserve Admirals. A 28- year reserve veteran, Merilees will serve as senior reserve officer for the Pacific area. He says, "NASA has been very understanding and supportive concerning [his] reserve activities." His liaison activities have helped provide water patrol security operations during shuttle launches.

Administrator Appoints Ross Director of Lewis Center

Lawrence J. Ross has been named director of the Lewis Research Center, Cleveland succeeding Dr. John Klineberg who becomes director of NASA's Goddard Space Flight Center. The appointments are effective July 1, 1990.

Ross joined NASA in 1963 and has been deputy director of the center since December 1987. As deputy director, Ross has shared responsibility for organizing, controlling and accomplishing missions assigned to the center. "Larry Ross's deep management experience at Lewis will serve well as the NASA program meets the exciting challenges ahead," said Truly.

During most of his career, Ross has served in an executive capacity. He also has been a design and test engineer responsible for environmental testing of the Centaur launch vehicle stage and for integration of the Surveyor spacecraft with the Atlas/Centaur launch vehicle.

Ross also has undertaken several special assignments including an investigation into the failure of a Delta launch vehicle and a study of management approaches for Space Station Freedom.

Richard Named DAA, Comm

Sue Mathis Richard has been named deputy associate administrator, Office of Communications, effective April 9, 1990. She works directly with the associate administrator on all matters concerning the news media, public services and television development.

Richard served as vice president, Industry Communications for the National Cable Television Assn., overseeing press, publicity and public relations activities for the cable industry prior to joining NASA.

Previously, Richard was Florida communications director for the Bush-Quayle Campaign and before that public relations manager for the Walt Disney World Co. She served as a special assistant to President Reagan and director of media relations at the White House before joining Walt Disney World.

In addition to her extensive managerial experience, Richard has held several key positions as a journalist, including Washington television correspondent for Cox Enterprises, Inc., and cable television anchor and producer in East Lansing, Mich. She also is a former instructor of English/Communications.

Kress Heads New Legislative Affairs Office

The newly established Office of Legislative Affairs, which reports directly to the administrator, is headed by Martin P. Kress, who was appointed acting assistant administrator by Admiral Truly effective March 18.

Kress came to NASA after serving as a senior professional staff member of the Senate Commerce Committee. His tenure on the Hill dates from 1979 when he joined the Senate Budget Committee as senior energy analyst. In 1983 he began service with the Science, Technology and Space Subcommittee of the Senate Commerce Committee. Kress drafted the Commercial Space Launch Act and the Land Remote Sensing Commercialization Act and has been active in working to form a consensus on the goals of the civilian space program.

The Office of Legislative Affairs is responsible for all legislative matters and the coordination of budgetary and policy issues with the Congress.

Taylor Named Chief Scientist, Space Station

William W. L. Taylor of TRW, Redondo Beach, Calif., has been named chief scientist for the Space Station Freedom program, Richard H. Kohrs, director, Space Station Freedom announced recently. In this position, Taylor will be the principal advocate for the space science community in the space station program.

Taylor has been with TRW since 1978, most recently as assistant department manager of the Physical Sciences Department of the Applied Technology Division. He is the principal investigator of the Waves in Space Plasmas investigation and the High Voltage Drainage investigation carried aboard the Long Duration Exposure Facility recently returned to Earth by the Space Shuttle after almost six years in space.

Taylor also is the U.S. science coordinator for ACTIVE, an international experiment on the propagation of low frequency radio waves, and a co-investigator on the Space Experiments with Particle Accelerators investigation. He is working with TRW on the proposed Neutral Environment With Plasma Interaction Monitoring System for the Freedom space station.

Prior to joining TRW, Taylor worked with NASA where he was program scientist for Spacelab 1.

ANOTHER DIVIDEND FROM AIR & SPACE

SWAMP TO SPACE

Rural Fire Protection

By Melinda K. Bowman, SSC

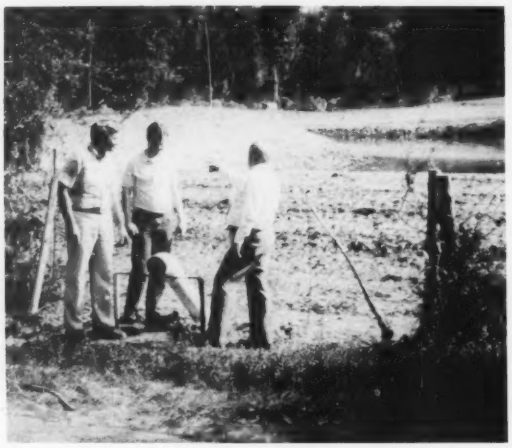
John C. Stennis Space Center, located in Harrison County, Mississippi, is involved in a project that could ultimately help rural property owners across America significantly increase the protection of their lives and property from fire hazards and lower their insurance rates.

The center has been in the satellite remote sensing business for years and is NASA's lead center for the commercialization of such technology.

But how will remote sensing help the rural land and home owner? In this instance, Stennis has used satellite imagery to locate existing water bodies in southeast Mississippi for the purpose of ultimately installing dry fire hydrants that can be used to fight rural fires. The dry hydrant is installed by digging a hole through the dam of a pond and inserting pipe with a filter to keep fish and other debris from coming through. The hydrant is then capped off until needed in an emergency.

A pilot project using remote sensing to aid in rural fire protection was done in Harrison County, Miss., as a joint effort between the Southeast Mississippi Conservation and Development Area and NASA.

In Mississippi, 51 percent of the state's population lives in rural areas. The primary reason for high insurance rates and loss of property and human life is the lack of water to extinguish disastrous blazes. But if you have your own "dry fire hydrant" coming from a pond out of your back door, chances for saving your property from total devastation are much greater. And, your annual insurance premiums could drop by $300 or more because of a lower fire rate.



A dry fire hydrant extends from pond to a point near a county road.

The objective of the Harrison County project is to establish a network of dry fire hydrants. This is being done through location of existing ponds and installation of dry hydrants. Gaps in the network, where ponds do not exist, are also being located. In such areas, county officials work with landowners for authorization to dig new ponds in locations that could serve several homes.

What NASA did for the pilot project was take imagery from the Landsat V satellite as it passed over Harrison County. The Stennis experts processed the data to determine existing pond size and exact location according to fire districts. The ponds were also rated by distance to nearest county roads and to nearest residences. It was then determined where the residences were located and who owned the land. By layering all of this data using a Geographic Information System format, NASA came up with a thorough analysis complete with the names of individual land owners and suggestions as to the best possible places for digging new ponds to aid in rural fire protection.

The advantage in using satellite imagery over conventional aerial photographs and topographic maps is the time and cost involved in gathering the data. It takes approximately 10 years to compile a complete topographic map going about things the conventional way as opposed to a matter of a couple of weeks using satellite data. Data can be gathered from the Landsat V satellite every 18 days for a specific area, and it's current data.

Rural fire protection is a major problem in the Southeast. As it is now, with little or no access to water, many homes burn to the ground with the local Volunteer Fire Department standing helplessly by. By employing this method of using existing farm ponds and constructing additional fire ponds in rural areas to be shared by a number of families in a one mile radius (which is Harrison County's plan) arson will be discouraged as well. Insurance companies will be happier, and life in the country will remain the good life. ■